FEDERAL ENERGY Managers 8/23/03

Growing Stronger Every Day
The Case for DG, CHP
And other Recycled Energy

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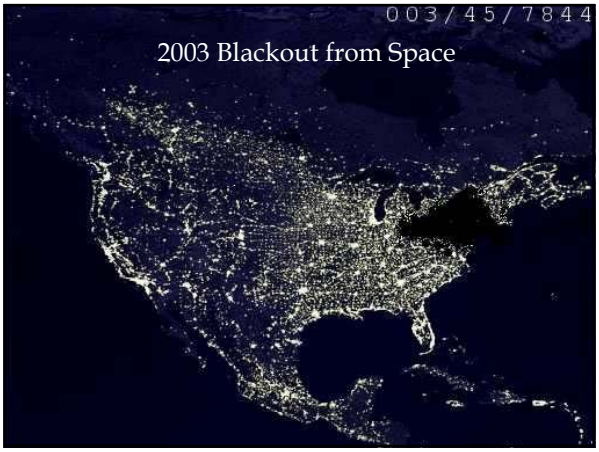
Humanity's Top Ten Problems for next 50 years

1. ENERGY
2. WATER
3. FOOD
4. ENVIRONMENT
5. POVERTY
6. TERRORISM & WAR
7. DISEASE
8. EDUCATION
9. DEMOCRACY
10. POPULATION

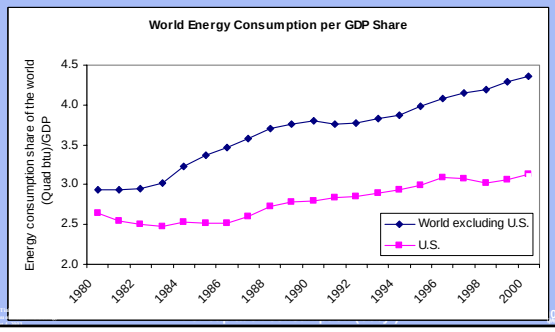
Nobel Laureate
Dr. Richard Smalley, 2003

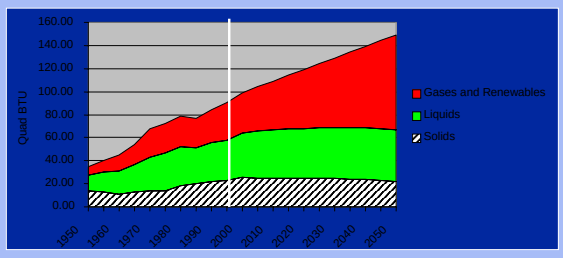


Energy Is Key to All Problems

- End use energy vital to economic growth, but;
  - Growing fossil use exacerbating environment, poverty, terrorism and war and democracy
- Mitigate in three ways:
  - Efficiency of energy use
  - Increased renewable use (may harm economy)
  - Recycle energy

The Problem
Economy/Efficiency



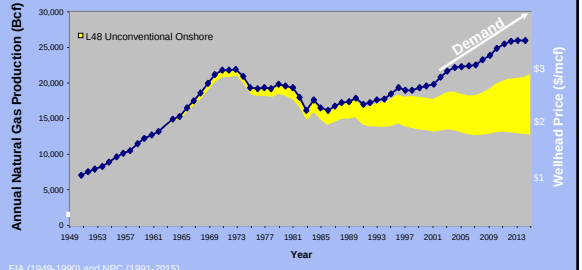


Global oil and coal consumption projected to remain at current levels for 30-50 years.

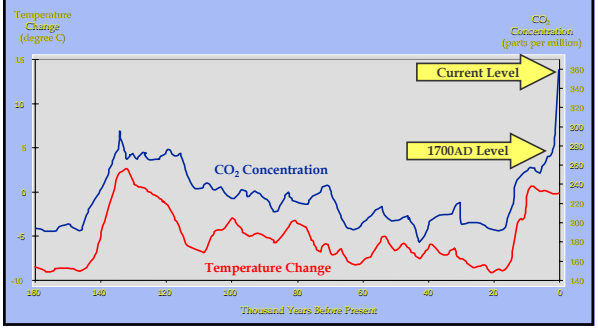
Natural gas and other energy sources will need to fill the global demand gap with business as usual.

But with this growth, US will increasingly import gas and cause global price pressure, economic problems

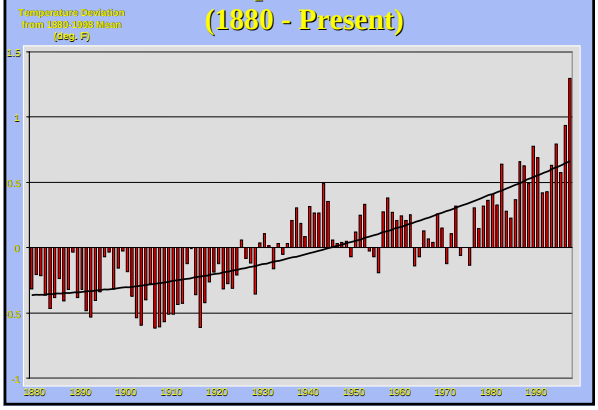
U.S. Natural Gas Production Trouble Ahead



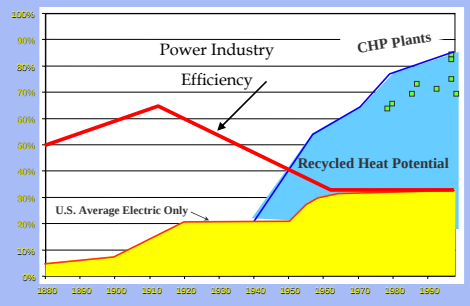
Atmospheric CO_2 Concentration and Associated Temperature Changes



Global Temperature Anomalies (1880 - Present)



Energy Generation Efficiency Curve



Mitigating Problems with DG

- Recycle energy now wasted with DG
- New CHP needed to enable recycling of normally wasted heat

Fundamental Flaw in US Energy

- Boilers make heat that was just thrown away, wasting the potential in fuel to do work
  - Fuel is like whole milk – has cream & skim milk – work or electricity and heat
  - Every dairy produces both products
  - Federal facility thermal plants waste the cream – make no electricity
  - All central electric plants waste the skim milk – waste the heat

Defining Recycled Energy

- *Useful energy derived from*
  - *(1) exhaust heat from any industrial process;*
  - *(2) industrial tail gas that would otherwise be flared, incinerated or vented; and*
  - *(3) pressure drop in any gas, excluding any pressure drop from a condenser that subsequently vents the resulting heat.*

Industrial Recycling

- Most industries have learned to 'rag pick' trash to recycle materials
  - Steel, aluminum, glass, paper and plastic industries all increasingly recycle product
- As a rule, energy is used once, then vented; recycling is the exception.
- Industrial waste heat, fuel, and pressure drop could supply 45 to 92 Gigawatts of fuel-free capacity – 13% of US peak

Waste Heat Potential

- Industry vents heat from coke ovens; metal, chemical, and glass production; gas compressor drives; and refineries
- This heat could supply 13,000 MW, 24/7
  - No added fossil fuel
  - No added pollution
  - No added greenhouse gas

Industrial Tail Gas

- US industry flares waste gas equivalent to 2.0 TCF of natural gas/year
  - The resulting heat is generally vented.
  - Picking these 'rags' could supply 19 gigawatts of new electric- only capacity, or
  - Support CHP with 15 GW of electric capacity and 50 GW of thermal capacity.

Steam Pressure Drop

- Most complexes, including Federal facilities distribute medium pressure steam, then waste the pressure drop energy.
  - Backpressure turbines can convert these steam pressure drop 'rags' into 12 to 20 GW of fuel-free electric capacity.
  - Elevate boiler pressure to increase the pressure difference and supply up to 50 GW electric capacity

Natural Gas Pressure Drop

- Pipeline gas is compressed for trans-mission, then deflated at city gates
  - Rag picking gas pressure drop would supply another 8 – 10 gigawatts of fuel free electric capacity.

Industrial Recycling Summary

- In total, industrial process waste energy could supply 45 to 92 gigawatts of electric capacity
- Picking these 'rags' would displace 2.4 quads per year – 2.5% of total US fuel consumption.
  - Recycling potential is concentrated in industrial states with significant coal based generation

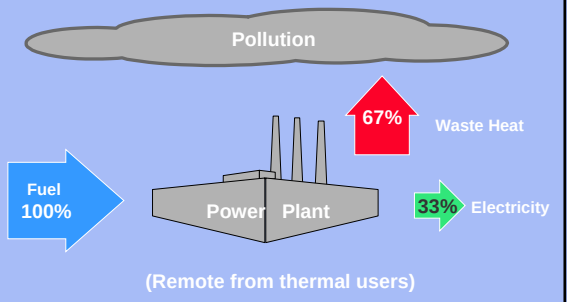
Industrial Recycled Energy Case Study: Primary Energy

- NiSource invested $300 million in six projects that recycle steel plant waste energy to supply 440 megawatts of electric capacity and 460 megawatts of steam capacity.
- The steel mills save over $100 million per year and avoid significant air pollution
  - The CO_2 reduction is equivalent to the uptake of one million acres of new trees.
- Such rag picking is profitable; the projects were recently sold for $335 million to Private Power

Larger Potential – CHP

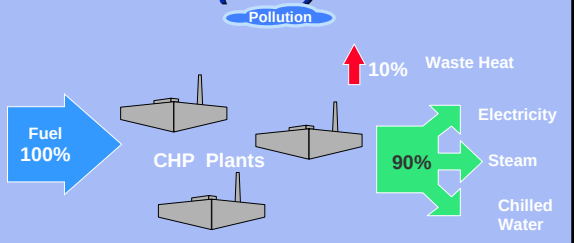
- 70% of US electricity generated with an aging fleet of fossil fueled central plants
- These plants deliver 31% of fuel's energy as electricity, waste the rest
- Central generation vented 17.6 quads in 2001, enough to replace 22 quads of boiler fuel
- Commercial and industrial sectors burned 25.6 quads in their boilers.

Conventional Generation



(Remote from thermal users)

Combined Heat and Power (CHP)



(On or near thermal user sites)

Why Don't Central Plants Recycle Waste Heat?

- Ton van der Does, father of Netherlands CHP, developed the "rule of sevens
  - It takes 7 times more energy to move a MWh of electricity a given distance than to move a MWh of fuel the same distance
  - It takes 7 times more energy to move a MWh of thermal energy than to move a MWh of electric energy, thus
  - It takes 49 times the energy to move a MWH of thermal versus a MWh of fuel.

Therefore:

It is prohibitively expensive to move waste heat from remote central plants to thermal users

Why Continue Central Generation?

- The world's approach to electric regulation was originally designed to speed electrification by giving early electric entrepreneurs monopoly protection.
- The rules penalize utility efficiency, block competition and discourage recycling
  - The rules remain, long after universal electrification, for two reasons: *assumed economy of scale* and *natural inertia*.

Economies of Scale?

- Regulations assume it is cheaper to produce power in a few large plants than in many small plants. But the assumption is flawed, even before counting DG ability to recycle heat.
- Consider impact of scale on efficiency and capital cost per delivered kW

Efficiency Comparisons

- 500 MW CCGT is 60% efficient but 9.7% of power lost in T&D, delivered efficiency 54%
- All backpressure turbines extract power with zero marginal fuel, infinite efficiency, sized down to 40 kW or .04 MW
- One MW fuel cell is 57% efficient but has no T&D losses and can recycle remaining heat
- Other CHP 30% - 45% efficient but recycles heat to achieve 85% - 95% total efficiency.

Capital Cost Comparisons

- 500 MW CCGT costs $800/kW to install, but:
  - Needs new T&D, average cost of $1200/kW
  - Suffers 20% line losses during peak hours
  - Capital cost per peak, delivered kW is $2500
- One MW fuel cell costs same -- $2500
- Backpressure turbine costs $300 - $1000/kW
- New gas turbine, gas engine or boiler/steam turbine plant costs $800 to $1200/kW.

Conclusion:

DG efficiency and capital cost better than CG on delivered basis

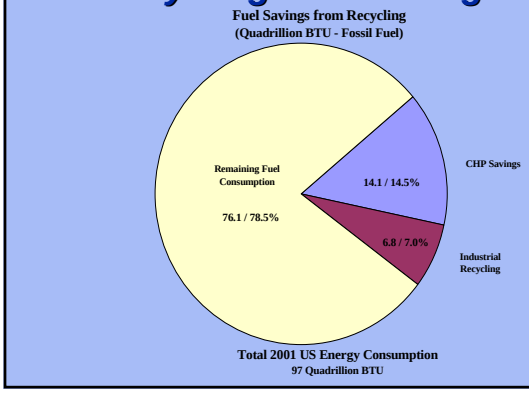
Last Minute Update

- Usual response claims T&D needs and costs are overstated. People do not want to believe that central generation is wrong.
- At 4:11 PM, EDT on Friday, August 15, the US transmission system made a powerful statement about its adequacy.

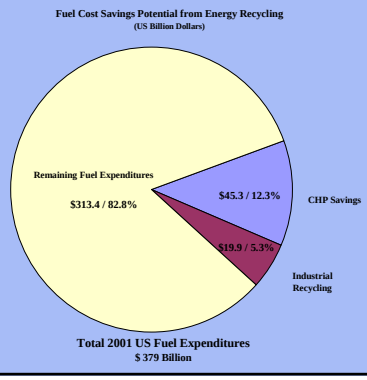
DG Problem 2 – Natural Inertia

- Attitudes, habits of mind, regulations and the power of incumbent firms are all slow to change
  - In competitive markets, insurgents niche sell disruptive technology; winners improve over time and replace incumbents
  - Competitive barriers have sheltered power industry from disruptive technology, which has retarded DG value proposition improvements
- DG now growing, rapidly improving value

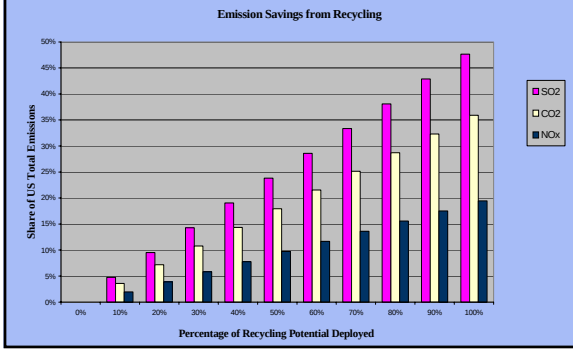
Recycling Fuel Savings



Recycling Cost Savings



Recycling Emission Reduction Potential



Actions to Induce Recycling

- Reward/penalize utilities for efficiency .
- Recognize locational value of DG
  - Avoids both T&D losses and new T&D investments
- Eliminate "les bans" the state laws prohibiting private wires or third party sales of electricity.
- Simplify and standardize interconnection rules
- Allow emissions/MWh of useful energy output – eliminate new source rules.
- Give recycled & renewable energy a preferred position since both are fuel & pollution free.
- Deploy real time electric pricing, giving the market needed price signals.

Current DG Deployment

- DG supplies 6.5% of US power, but individual states use ranges from 0% to 33%
- Nations generate 2% to 40% of power with DG
- All states have access to same technology and fuel prices, suggesting differences due to barriers

Implications for FEMP

- Recycling energy could, over time, displace 25% of US fuel.
- Recycling mitigates key world problems:
  - Cost of energy
  - Competitive strength of US industry
  - Vulnerability to weather and terrorists
  - Balance of payments
  - Air pollution
  - Climate change

Implications continued

- Gas prices & electric deregulation are causing energy price sticker shock
- DG/CHP industry is mobilizing, making policy makers aware of options
- Transmission congestion is growing worse, forcing consideration of DG (Written before 8/15/03 blackout)
- Change will be abrupt, not continuous, triggered by some "tipping point" event
- When DG, not whether, is the question.

FEMP Takeaway

Recycle energy in your facility, then deploy CHP to serve base thermal load, recycle more energy, mitigate many problems